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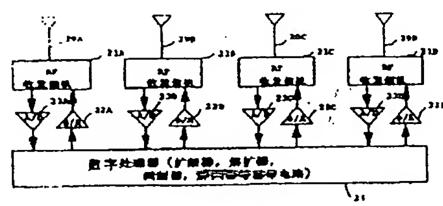
[54]发明名称 同步码分多址通信链路的建立和保持方法

[57]摘要

本发明涉及一种在同步码分多址 CDMA 无线通信系统中建立和保持基站与大量用户间链路的方法，包括下行链路的同步建立、上行链路的同步建立及为防止链路建立时争抢的方法。本方法运用求相关来获得同步定时，用在无线信令中相应时隙的设计来保证同步与功率控制的闭环过程，特别是使用了时隙 EMPTY，使同步和功率的检查更为可靠，接入码道的高效率使用方法使系统接入时用户争抢接入码道的概率大为降低。本方法比传统同步 CDMA 系统中所使用的方法简单并易于实现。



权 利 要 求 书

1. 一种同步码分多址通信链路的建立和保持方法，其特征在于所述同步码分多址通信链路的建立方法包括以下步骤：

1)．将下行接入码序列设计成至少含有保护时隙、训练序列时隙、用于同步调整的时延偏差时隙、用于功率调整的功率控制时隙的帧结构；将上行接入码序列设计成至少含有保护时隙、同步1时隙、空时隙的帧结构，将下行业务码序列设计成至少含有保护时隙、空时隙、用于同步调整的时延偏差时隙、用于功率调整的功率控制时隙的帧结构，将上行业务码序列设计成至少含有保护时隙、空时隙、空/同步2时隙的帧结构；

2)．基站在下行接入码道中以下行接入码序列向所有终端发射建立通信的下行接入信号，加电终端用已知的通用下行码序列搜索基站的训练序列，识别出上行接入码道及下行接入码道；

3)．终端根据接收的训练序列的信号电平及接入码道的有效区域信息估计终端距基站的距离并估算出延时发射的时间及发射功率，根据估算的发射功率和时延以上行接入码序列发射接入请求信号；

4)．基站搜索使用上行接入码序列的训练信号，将检测到的时延量与系统设定的参考值进行比较后获得时延偏差，将接收到的信号功率电平与现存信号电平进行比较后获得功率控制信号，并在下行接入码道中以下行接入码序列发送信道接入的确认信号；

5)．终端根据接收的下行码序列的时延偏差信号和功率控制信号调整发射时间和功率电平，根据指定的码道号，以上行码序列发射链路的初始信号；

所述同步码分多址通信链路的保持方法是：指定码道号的终端在其上行业务码道中的空/同步2时隙，以其上行业务码序列周期性地发射同步2符号，基站通过计算相关值和搜索峰值，确定此终端同步2信号的到达时间，并根据峰值和时间计算出终端的上行同步误差，在下一个下行业务码道~~中~~用同样的下行业务码序列发送此时延偏差信号，供终端调整发射时间保持同步。

2.根据权利要求1所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述上行接入码序列与下行接入码序列间的保护时隙及所述上行业务码序列与下行业务码序列间的保护时隙大于模拟电路的开关时间和大于2倍的终端与基站间的最大距离或小区的最大半径与大气中光速之比。

3.根据权利要求1所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述的上行信道与下行信道是时间上不重叠的上、下行时隙，在频段上可以相同，上行时隙与下行时隙组成一对，在时间上重复循环。

4.根据权利要求1所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述的下行接入码道中的训练序列是全向发射的，具有比其他信号高的电

平。

5.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述链路的建立方法还包括对定时偏差和功率控制信息的差错检测及更正。

6.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述链路的建立方法还包括对接入请求信号及接入确认信号的终端唯一个人号码 PID 信息的检测。

7.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述链路的建立方法还包括对接入请求信号、接入确认信号以及链路初始信号的差错检测及更正。

8.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述的步骤 4 ）中基站发射链路确认信号是在基站接收到上行时隙的接入请求信号后的下一个下行时隙进行的。

9.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述的步骤 3 ）中，各终端是在其个人号码的最后 5 比特与下行接入码序列的帧号相同时，才在上行时隙发射接入请求信号，在接入失败时，终端随机延时一定时间后再重复发射接入请求信号。

10.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述的步骤 3 ）中，特定的固定终端记录前一次成功通信时的上行延时值，并在下一次接入时使用该值作为初始延时值。

11.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于所述的检测接入请求信号的训练序列，还进一步包括：以一个码片周期几分之一的精度，使用上行接入码序列在基站计算接收到的信号的相关峰，找到超过预定门限值的相关峰，将确认的相应时间作为到达时间的数值；如果任一个到达时间的数值处于以参考时间为中心的一个预先确定的范围内，选取最接近参考时间的那个时间数值作为到达时间的目标值，其相应的相关峰作为其功率估值；如果没有一个到达时间的数值落在上述预定范围内，则选~~取具~~有最大相关峰的那一个到达时间数值作为到达时间目标值，其相应的相关峰作为目标功率估值；如果没有上述到达时间数值，取上述预定参考时间为目标到达时间数值，取预定参考功率为目标功率估值；所述的计算定时偏差和功率控制范围，其中定时偏差为到达时间目标值与所述参考时间之差，所述功率控制范围为目标功率估值与参考功率的比值；所述的定时偏差和功率控制范围的信息均在下行接入信号、链路确认信号中发射。

12. 根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述终端在上行业务码道的空/同步 2 时隙中，只有特定的一个或几个终端在此当前帧中能发射同步 2 信号，其它正在通信的终端只能处于不发射的空时隙，使只有此一个或几个指定的终端的同步 2 信号能被基站接收。

13. 根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于：所述基站下行接入码道中的训练序列时隙与下行业务码道中的空时隙 EMPTY 在时间上是重叠的，即在此下行时隙中，基站只在其下行接入码道中发射训练序列，而其它业务码道在此时隙均不发射；所述终端在上行接入码道中的同步 1 时隙与上行业务码道中的空时隙在时间上是重叠的，即在此上行时隙中，只有要求接入的终端才发射同步 1 信号，而正在通信的其它终端在其上行业务码道的此时隙不发射。

14.根据权利要求 1 所述的同步码分多址通信链路的建立和保持方法，其特征在于还包括防止在接入码道中出现争抢的方法,包括:

1).在下行接入码道的帧结构中设计忙闲 B/I 时隙，在基站所有业务码道均被占用或此接入码道正在处理接入时示忙，当终端接收到下行接入码道的此时隙示忙时，只有特权用户或特殊服务号码呼叫能强行在其上行接入码道中申请强行接入，其它处于等待状态的终端均不能发射上行接入请示信号;

2).上、下行接入码道仅处理终端的接入，而在所分配的业务码道中处理用户鉴权和主叫、被叫电话号码的传送，即接入码道在绝大多数时间内处于空闲状态;

3).将用户终端进行分组处理，基站对用户终端的呼叫和终端的接入请求都只能在分组的特定的上、下行帧中进行;

4).出现争抢，基站无法分辩所收到的上行接入请求信号和终端无法获得接入的确认信号时，终端将随机延时一段时间后再次发出接入请求。

What is claimed is:

1. A radio communication system comprising:

a transmitting station which comprises:

a plurality of orthogonal code generating means for generating a plurality of orthogonal codes which are different from each other;

a plurality of spreading means for spreading transmission data through the plurality of orthogonal codes;

a plurality of modulation means for modulating spread signals that have been spread by the plurality of spreading means; and

a plurality of transmission means for transmitting the modulated signals that have been modulated by the plurality of modulation means from a plurality of different transmission antennas in the form of a plurality of radio signals, and

a receiving station which comprises:

reception means for receiving, through a single receiving antenna, the plurality of radio signals that have been transmitted by the plurality of transmission means;

a plurality of reverse spreading means for reverse spread and output, through the plurality of orthogonal codes, of the plurality of radio signals received by the reception means;

selection means for selecting, on the basis of a detection level, one of the plurality of reverse spread outputs that are output from the reverse spreading means; and

deciding means for reproducing received data corresponding to the transmission data from one of the reverse spread outputs selected by the selection means.

2. A radio communication system as defined in claim 1, wherein the plurality of modulation means modulate, at a given carrier frequency, the spread signals that have been spread by the plurality of spreading means.

3. A radio communication system as defined in claim 2, wherein the plurality of transmitting antennas are a plurality of antennas positioned in differing spatial locations relative to each other.

4. A radio communication system as defined in claim 1, wherein the plurality of modulation means modulate, at different carrier frequencies, the spread signals that have been spread by the plurality of spreading means.

5. A radio communication system as defined in claim 1, wherein the orthogonal codes are Walsh functions.

6. A radio communication system as defined in claim 1, wherein the radio communication system comprises:

a base station having the transmitting station; and

a plurality of mobile stations each having the receiving station and being linked with the base station via a radio link, and

wherein the transmission data comprises:

control data transmitted from the base station to the plurality of mobile stations.

7. A radio communication system as defined in claim 1, wherein the radio signals are transmitted by time division duplex.

8. A radio communication system as defined in claim 1, wherein the reverse spreading means comprises matched filters corresponding to the orthogonal codes.

9. A radio communication system as defined in claim 1, wherein the reverse spreading means comprises correlation means corresponding to the orthogonal codes.

10. A radio communication system comprising:

a transmitting station which comprises:

a plurality of orthogonal code generating means for generating a plurality of orthogonal codes which are different from each other;

a plurality of spreading means for spreading transmission data through the plurality of orthogonal codes;

a plurality of modulation means for modulating spread signals that have been spread by the plurality of spreading means; and

a plurality of transmission means for transmitting the modulated signals that have been modulated by the plurality of modulation means from a plurality of different transmission antennas in the form of a plurality of radio signals, and

a receiving station which comprises:

reception means for receiving, through a single receiving antenna, the plurality of radio signals that have been transmitted by the plurality of transmission means;

a plurality of reverse spreading means for reverse spread and output, through the plurality of orthogonal codes, of the plurality of radio signals received by the reception means;

adding means for adding the plurality of reverse spread outputs output from the reverse spreading means; and

deciding means for reproducing received data corresponding to the transmission data from the reverse spread outputs added by the adding means.

11. A radio communication system as defined in claim 10, wherein the adding means comprises weighting means for multiplying the plurality of reverse spread outputs from the reverse spreading means by weight factors in accordance with the individual reverse spread output levels, prior to the addition process.

12. A radio communication system as defined in claim 10, wherein the plurality of modulation means modulate, at a given carrier frequency, the spread signals that have been spread by the plurality of spreading means.

13. A radio communication system as defined in claim 12, wherein the plurality of transmitting antennas are a plurality of antennas positioned in differing spatial locations relative to each other.

14. A radio communication system as defined in claim 10, wherein the plurality of modulation means modulate, at different carrier frequencies, the spread signals that have been spread by the plurality of spreading means.

15. A radio communication system as defined in claim 10, wherein the orthogonal codes are Walsh functions.

16. A radio communication system as defined in claim 10, wherein the radio communication system comprises:

a base station having the transmitting station; and

a plurality of mobile stations each having the receiving station and being linked with the base station via a radio link, and

wherein the transmission data comprises:

control data transmitted from the base station to the plurality of mobile stations.

17. A radio communication system as defined in claim 10, wherein the radio signals are transmitted by time division duplex.

* * * * *

antennas (N) were 2 was described, but N can be any number equal to 2 or greater. Superior diversity effects are achieved with greater numbers.

Also, in the foregoing embodiments, a space diversity effect was achieved through differences in the spatial locations of the plurality of antennas. However, similar diversity effects can be achieved by varying the directionality of the plurality of antennas, by changing the frequency used, or by using a plurality of signals with varying wave propagation characteristics.

A block diagram of a transmitting station design in which the number of N is 2 and the frequency has been changed is shown in FIG. 10, and a block diagram of the design of a corresponding receiving station is shown in FIG. 11.

In FIGS. 10, 11 and 12 indicate orthogonal code generators, 21 and 22 indicate spreaders, 31 and 32 indicate transmitting antennas, 40 and 41 indicate oscillators, and 51 and 52 indicate BPSK (binary phase shift keying) modulators.

Transmission data is spread by the spreaders 21 and 22 by means of the two orthogonal codes generated by the orthogonal code generators 11 and 12. After spread, the two signals are subjected to binary phase shift modulation by the BPSK modulators 51 and 52, and are then transmitted from the antennas 31 and 32. The two BPSK modulators 51 and 52 are provided with carrier waves generated by the oscillators 40 and 41.

Here, the oscillators 40 and 41 are oscillators with different frequencies. The transmission data that has been spread by the spreaders 21 and 22 by means of two orthogonal codes generated by the orthogonal code generators 11 and 12 is subjected to binary phase shift modulation by the BPSK modulators 51 and 52 with the carrier waves of different frequencies provided by the oscillators 40 and 41, and are transmitted from the antennas 31 and 32.

In FIG. 11, 100 indicates a receiving antenna, 110 and 111 indicate coherent detectors, 120 indicates a carrier wave reproduction circuit, 131 and 132 indicate matched filters, 145 indicates an adder, and 150 indicates a decider. 121 and 122 are carrier wave reproduction circuits for reproducing the frequencies of the oscillators 40 and 41 depicted in FIG. 10; the other circuits are the same as those depicted in FIG. 8.

Signals from the transmitting station that have been received by the receiving antenna 100 are detected at the coherent detectors 110 and 111 through the reproduced carrier waves from the carrier wave reproduction circuits 121 and 122, and the baseband signals obtained as a result are passed through the matched filters 131 and 132, which correspond t0 the spread signal 1 and the spread signal 2 on the transmitting side, and are subjected to reverse spread. The outputs of the matched filters 131 and 132 are subjected to addition by the adder 145, a decision is made by the decider 150, and the received digital data is reproduced.

In the foregoing embodiment, reverse spread is performed by the matched filters, but a combination of reference pattern generators and correlators could be used in place of the matched filters.

In FIG. 12, the design of a receiving station which uses correlators 230-1 and 230-2 in place of the matched filters 131 and 132 depicted in FIG. 1 is depicted. Reverse spread is carried out using a combination of the correlators 230-1 and 230-2, a reference pattern 1 generator 231, which corresponds to the orthogonal code generator 11, and a reference pattern 2 generator 232, which corresponds to the orthogonal code generafor 12.

Signals from the transmitting station that have been received by the receiving antenna 100 are detected at the coherent detector 110 through the reproduced carrier wave from the carrier wave reproduction circuit 120, and the baseband signals obtained as a result are passed through the correlators 230-1 and 230-2 which correspond respectively to the spread signal 1 and the spread signal 2 on the transmitting side, and are subjected to reverse spread.

From the outputs of the correlators 230-1 and 230-2, the output with the higher peak level or average level is selected at the selector 140, a decision is made by the decider 150, and the received digital data is reproduced.

FIG. 13 is an example of a specific circuit design of the correlator 230 used in FIG. 12. The product of the received signal and the reference pattern is executed time-sequentially by the EX-OR (exclusive-OR) circuit 2301, and the result of the product of the received signal and the reference pattern is smoothed by the low-pass filter 2302. The design of the correlator 230 can be viewed as one in which the multipliers 1303 of the matched filters 131 and 132 depicted in FIG. 6 are replaced with one EX-OR (exclusive-OR) circuit 2301 so that the product will be smoothed time-sequentially.

FIG. 14 is an example of a specific circuit design of the reference pattern generator used by the correlator 230. It comprises a ROM 2311 which stores the reference pattern and a readout clock circuit 2312.

FIG. 15 depicts the design of the receiving station of FIG. 8, and is a circuit block diagram which depicts the case when a delay detector 115 is used in place of the coherent detector 110. Signals from the transmitting station that have been received by the receiving antenna 100 are detected by the delay detector 115 through the local oscillation carrier wave from the local oscillator 125. Subsequent operations are the same as in the case of FIG. 8.

FIG. 16 depicts a specific design of the BPSK delay detector 115. In this circuit, received signals from the antenna are mixed with local oscillation signals by the double-balance mixer element 1151, and the low-band waves are taken out by the low-pass filter 1152; and are multiplied at the multiplier 1154 with the signal itself which has passed through the delay circuit 1153 for one code portion of the spread code, to form a delay detection output.

The use of the delay detector 115 in place of the coherent detector 110 has the advantage that phase control of the local oscillator 125 becomes unnecessary, and that the frequency precision need not be so stringent. Depending on the usage condition, either one of the detectors is used.

With the present invention described above, the transmission data is spread at the transmitting side, the spread data is transmitted as a plurality of radio signals with different propagation conditions, the plurality of radio signals are received and subjected to reverse spread at the receiving side, and the transmission data is reproduced from one of these signals or an added signal of the plurality of signals. This makes transmission diversity possible even in the case of radio communication directed from a base station to mobile stations, and allows the required transmission power to be reduced.

Since the foregoing design permits the transmission power to be reduced, the device can be made smaller, cost reduction is possible, and interference with other communication systems can be minimized.

In addition, transmission of initial communication calls, notification of system parameters, and other control data from a base station to mobile stations can be conducted accurately and reliably without fading-induced errors.

transmission after the independent spread signals for each communication channel have been multiplied by the original data signals, in order to realize multiplex communication on the same modulation frequency at the same time.

The spread signal i depicted in FIG. 4(*b*) and the spread signal 2 depicted in FIG. 4(*c*) are orthogonal to each other; the use of a suitable matched filter and correlator on the receiving side allows the data to be separated and reproduced independently.

The spread signal 1 depicted in FIG. 4(*b*) and the spread signal 2 depicted in FIG. 4(*c*) are examples of Walsh functions.

The transmission code depicted in FIG. 4(*d*) and the transmission code depicted in FIG. 4(*e*) are computed as the logical product of the transmission data depicted in FIG. 4(*a*) and the spread signal 1 depicted in FIG. 4(*b*) or the spread signal 2 depicted in FIG. 4(*c*) at a given point in time; these computations may be accomplished easily in practice using an EX-OR (exclusive-OR) element.

On the receiving side, signals from the transmitting station that have been received by the receiving antenna **100** are detected by the coherent detector **110** through the reproduced carrier wave from the carrier wave reproduction circuit **120**, and the baseband signals obtained as a result are passed through the matched filters **131** and **132**, which correspond to the spread signal 1 and the spread signal 2 on the transmitting side, and are subjected to reverse spread.

The output with the higher peak level or higher average level is selected from the outputs of the matched filters **131** and **132**, a decision is made by the decider **150**, and the received digital data is reproduced.

FIG. 5 depicts a specific design for a coherent detector for BPSK **110** used in the receiving station depicted in FIG. 1. A commercially available double-balanced mixer element **1101** and a low-pass filter **1102** are used in these circuits. A delay detector, described later, can be used in place of the coherent detector **110**.

FIGS. 6(*a*) and 6(*b*) depict specific designs for the matched filters **131** and **132**. In the figure, **1301** indicates a comparator, **1302** indicates an 8-stage shift register, **1303** indicates a multiplier, **1304** indicates an 8-bit memory, and **1305** indicates an adder. FIG. 6(*a*) illustrates the case of the matched filter 1 (**131**) which corresponds to the orthogonal code 1 depicted in FIG. 4(*b*); a value corresponding to the orthogonal code 1 is stored in the 8-bit memory **1304-1** as +1 (true) and −1 (false). In the case of the matched filter 2 (**132**) which corresponds to the orthogonal code 2 depicted in FIG. 4(*c*), only the contents of the 8-bit memory **1304-2** are shown in FIG. 6(*b*). Other parts of the matched filter 2 are the same as those of the matched filter 1 (**131**).

To describe briefly the operation of this circuit, the output of the detector is passed through the comparator **1301** and is Converted into a code expressed in +1 (true) and −1 (false), and stored in order in the 8-stage shift register **1302**. An orthogonal code expressed in +1 (true) and −1 (false) is stored in the memory **1304**, each bit in the shift register **1302** and each bit in the memory **1304** is multiplied by the multiplier **1303**, and the total is added by the adder **1305**. Therefore, if each bit in the shift register **1302** and each bit in the memory **1304** completely match, the adder **1305** has a value of +8, and if totally opposite, the adder **1305** has a value of −8, so that if the codes are orthogonal, the output is zero. By determining whether the output is positive or negative, it is possible to reproduce the received digital data.

FIG. 7 depicts the structure of the selector **140**. The magnitude of the output levels of the matched filters **131** and **132** are compared by a comparator **1401**, and a switching circuit **1402** is controlled such that the greater one is selected.

FIG. 8 is a block diagram depicting the design of a receiving station in another embodiment of the radio communication system pertaining to the present invention. It receives signals from the transmitting station in place of the receiving station of the radio communication system depicted in FIG. 1.

In FIG. 8, **100** indicates a receiving antenna, **110** indicates a coherent detector, **120** indicates a carrier wave reproduction circuit, **131** and **132** indicate matched filters, **145** indicates an adder, and **150** indicates a decider; all circuits are the same as those depicted in FIG. 1, with the exception of the adder **145**.

Signals from the transmitting station that have been received by the receiving antenna **100** are detected at the coherent detector **110** through the reproduced carrier wave from the carrier wave reproduction circuit **120**, and the baseband signals obtained as a result are passed through the matched filters **131** and **132**, which correspond to the spread signal 1 and the spread signal 2 on the transmitting side, and are subjected to reverse spread. The outputs of the matched filters **131** and **132** are subjected to addition by the adder **145**, a decision is made by the decider **150**, and the received digital data is reproduced.

With the receiving station design depicted in FIG. 8, the outputs of the two matched filters **131** and **132** are subjected to addition for output, rather than selecting the output of one of the filters. This design serves to minimize the effects of noise, such as momentary interruptions, to the extent that addition is performed.

FIG. 9 is a block diagram depicting the design of a receiving station in another embodiment of a radio communication system pertaining to the present invention. It receives signals transmitted from the transmitting station in place of the receiving station of the radio communication system depicted in FIG. 1.

In FIG. 9, **100** indicates a receiving antenna, **110** indicates a coherent detector, **120** indicates a carrier wave reproduction circuit, **131** and **132** indicate matched filters, **145** indicates an adder, **150** indicates a decider, and **161** and **162** indicate weighting circuits. All circuits are the same as those depicted in FIG. 8, with the exception of the weighting circuits **161** and **162**.

Signals from the transmitting station that have been received by the receiving antenna **100** are detected at the coherent detector **110** through the reproduced carrier wave from the carrier wave reproduction circuit **120**, and the baseband signals obtained as a result are passed through the matched filters **131** and **132**, which correspond to the spread signal 1 and the spread signal 2 on the transmitting side, and are subjected to reverse spread. The outputs of the matched filters **131** and **132** are weighted in accordance with reception level by the weighting circuits **161** and **162**, subjected to addition by the adder **145**, a decision is made by the decider **150**, and the received digital data is reproduced.

With the receiving station design depicted in FIG. 9, prior to addition, the outputs of the matched filters **131** and **132** are weighted in accordance with their reception level by the weighting circuits **161** and **162**, which place greater weight on higher reception levels, and addition is then performed by the adder **145**. This weighting process increases the relative weight placed on higher reception levels, further enhancing resistance to noise.

In the foregoing embodiments, a case in which the number of orthogonal codes and the number of transmission

output, through the plurality of orthogonal codes, of the plurality of radio signals received by the reception means, adding means for adding the plurality of reverse spread outputs output from the reverse spreading means, and deciding means for deciding the reverse spread output added by the adding means.

Alternatively, here, the adding means is provided with weighting means for multiplying the plurality of reverse spread outputs output from the reverse spreading means by weight factors in accordance with the individual reverse spread output levels, prior to the addition process. By means of this design, transmission diversity is possible even where there is yet no information regarding the location, direction, etc., of the partner station, or when the base station is to transmit data directed to all of a plurality of mobile stations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram depicting the design of a radio communication system pertaining to an embodiment of the present invention;

FIG. 2 is a conceptual diagram depicting a communication system in which the present invention is implemented;

FIG. 3 is a block diagram depicting the BPSK modulators used in the transmitting station depicted in FIG. 1;

FIGS. 4(*a*)–4(*e*) is an explanatory diagram depicting the spread performed in the embodiment depicted in FIG. 1;

FIG. 5 is a block diagram depicting a coherent detector for BPSK used in the receiving station depicted in FIG. 1;

FIGS. 6(*a*) and 6(*b*) are block diagrams depicting the matched filters used in the receiving station depicted in FIG. 1;

FIG. 7 is a block diagram depicting the selector used in the receiving station depicted in FIG. 1;

FIG. 8 is a block diagram depicting another design of the receiving station in a radio communication system pertaining to an embodiment of the present invention;

FIG. 9 is a block diagram depicting another design of the receiving station in a radio communication system pertaining to an embodiment of the present invention;

FIG. 10 is a block diagram depicting another design of the transmitting station in a radio communication system pertaining to an embodiment of the present invention;

FIG. 11 is a block diagram depicting the design of a receiving station for the embodiment depicted in FIG. 10;

FIG. 12 is a block diagram depicting another design of the receiving station in a radio communication system pertaining to an embodiment of the present invention;

FIG. 13 is a block diagram depicting the correlator used in the receiving station depicted in FIG. 12;

FIG. 14 is a block diagram depicting the reference pattern generator used in the receiving station depicted in FIG. 12;

FIG. 15 is a block diagram depicting another design of the receiving station in an embodiment of the present invention; and

FIG. 16 is a block diagram of a delay detector for BPSK used in the receiving station depicted in FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a block diagram depicting a design of the transmitting station in one embodiment of the radio communication system which pertains to the present invention.

In this embodiment, the number of orthogonal codes and the number of transmitting antennas (N) is 2. In FIG. 1, on the transmitting side, 11 and 12 indicate orthogonal code generators, 21 and 22 indicate spreaders, 31 and 32 indicate transmitting antennas, 40 indicates an oscillator, and 51 and 52 indicate BPSK (binary phase shift keying) modulators. On the receiving side, 100 indicates a receiving antenna, 110 indicates a coherent detector, 120 indicates a carrier wave reproduction circuit, 131 and 132 indicate matched filters, 140 indicates a selector, and 150 indicates a decider.

On the transmitting side, transmission data is spread by the spreaders 21 and 22 by means of the two orthogonal codes generated by the orthogonal code generators 11 and 12. After spread, the two signals are subjected to binary phase shift modulation by the BPSK modulators 51 and 52, and are then transmitted from the antennas 31 and 32. The two BPSK modulators 51 and 52 are provided with a given carrier frequency generated by the oscillator 40.

Here, the transmitting antennas 31 and 32 differ from each other in spatial location, producing a space diversity effect.

FIG. 2 depicts a communication system in which the present invention is implemented. As depicted in FIG. 2, in a communication system comprising a single base station 60 and a plurality of mobile stations 71–77, after bidirectional communication has been established between the base station 60 and a mobile station 71 (as indicated by the solid line in FIG. 2), or where data is to be transmitted from the mobile stations 71–77 to the base station 60, or in similar cases, transmitting antenna control from the base station 60 directed to the mobile station 71 is possible on the basis of reception diversity signals received when communication from the mobile stations 71–77 directed to the base station 60 has been received by the base station 60.

For communications other than those mentioned above, communication from the base station 60 to all of the mobile stations 71–77 (indicated by the dotted lines in FIG. 2) is necessary in many cases.

Examples are calls to mobile stations, or cases where system parameters indicating base station ID, location, and the like are to be broadcast. In such cases, reception diversity control signals when communications directed to the base station 60 from the mobile stations 71–77 are received by the base station 60 cannot be used in transmitting antenna control from the base station 60 directed to the mobile station 71.

An object of the present invention is to make possible transmission diversity, even in the case of initial transmission, where there is yet no information regarding the location, direction, etc., of the partner station, or where the base station is to communicate with all of a plurality of mobile stations, such as in mobile communication systems, and in similar cases.

FIG. 3 depicts in detail the BPSK modulators 51 and 52 depicted in FIG. 1. The circuit is realized using a commercially available double-balanced mixer element 501, through execution of the product of the modulated baseband signal and the carrier wave.

FIG. 4 depicts aspects of spread performed in this embodiment. In FIG. 4, the horizontal axis indicates time and the numerals indicate the logical state of the signals.

In FIG. 4, the 3-bit transmission data (1,0,0) depicted in FIG. 4(*a*) is spread by the spread signal 1 depicted in FIG. 4(*b*) and the spread signal 2 depicted in FIG. 4(*c*) (with clock speeds eight times the transmission data), and the 24-bit transmission code 1 depicted in FIG. 4(*d*) and the transmission code 2 depicted in FIG. 4(*e*) are generated and transmitted.

This spread method is termed spread spectrum or code division multiple access (CDMA), and involves modulated

RADIO COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a radio communication system, and more particularly to a radio communication system intended to reduce transmission power by adopting a diversity method on the transmitting side.

2. Description of the Related Art

It is usually the case in radio communications that radio frequency signals transmitted between a given transmitting station and receiving station are sometimes propagated over different paths; this can produce the phenomenon called "fading", whereby individual component wave interference and the like produces fluctuations in received wave level. Diversity is a technique used to overcome the phenomenon of fading.

One common diversity technique that is widely used is reception diversity, whereby a plurality of antennas is provided on the receiving side for signal reception and the strongest signal is selected, or by addition, in some selected ratio, of signals received by a plurality of antennas in order to produce a strong signal.

Transmission diversity, whereby a plurality of antennas is provided on the transmitting side, is also used in some cases. In such cases, it is necessary to decide, for the plurality of antennas, the ratio at which transmission will take place from each antenna, with reference to the conditions of wave propagation between the transmitting station and the receiving station which are to communicate.

In TDD (time division duplex) communication, whereby transmission and reception are conducted by time-division multiplex communication at the same given frequency, one method for achieving transmission diversity involves receiving radio signals with a plurality of antennas, determining the antennas with high reception levels, and using these antennas for transmission.

This method can be used only when the communication partner has been determined. That is, when bidirectional communication is conducted by TDD communication between designated radio stations, it is possible to select the antenna for transmission on the basis of received signal level data.

In the case of initial transmission, where there is yet no information regarding the location, direction, etc., of the partner station, or when communication is to take place with all of a plurality of stations within the base station area, such as in mobile communication systems, and in similar cases, it is impossible to determine which of the plurality of antennas should be used for transmission, making transmission diversity impossible.

In such cases in the past, the only way to conduct communication with a quality equivalent to that when communication by TDD has been established and transmission diversity by TDD is employed was to increase transmission output.

However, increasing transmission output has cost disadvantages and the additional drawback that interference with other communication systems increases.

SUMMARY OF THE INVENTION

As noted above, in conventional radio communications, transmission diversity is impossible in initial-stage communication or in the case of transmission to numerous unspecified stations, thus making it necessary to increase transmission output. This has disadvantages in terms of cost and increased interference with other communication systems.

An object of the present invention is to provide a radio communication system that makes transmission diversity possible, even in the case of initial transmission where there is yet no information regarding the location, direction, etc., of the partner station, or where a base station is to transmit data directed to all of a plurality of mobile stations, such as in mobile communication systems, and in similar cases.

In order to achieve this object, the present invention is a radio communication system comprising a transmitting station which comprises a plurality of spreading means for spreading transmission data through a plurality of orthogonal codes, a plurality of modulation means for modulating spread signals that have been spread by the plurality of spreading means, and a plurality of transmission means for transmitting the modulated signals that have been modulated by the plurality of modulation means from a plurality of different transmission antennas in the form of a plurality of radio signals, and a receiving station which comprises reception means for receiving, through a single receiving antenna, the plurality of radio signals that have been transmitted by the plurality of transmission means, a plurality of reverse spreading means for reverse spread and output, through the plurality of orthogonal codes, of the plurality of radio signals received by the reception means, selection means for selecting, on the basis of detection level, one of the plurality of reverse spread outputs that are output from the reverse spreading means, and deciding means for deciding on one of the reverse spread outputs selected by the selection means.

The plurality of modulation means modulate, at a given carrier frequency, the spread signals that have been spread by the plurality of spreading means.

At this time, the plurality of transmitting antennas are a plurality of antennas positioned in differing spatial locations relative to each other.

Alternatively, the plurality of modulation means modulate, at different carrier frequencies, the spread signals that have been spread by the plurality of spreading means.

Here, the orthogonal codes are characterized by being Walsh functions.

Here, the radio communication system comprises a base station having the transmission station and, a plurality of mobile stations each having the receiving station and being linked with the base station via a radio link, and the transmission data is control data transmitted from the base station to the plurality of mobile stations.

Here, the radio signals are transmitted by time division duplex.

Further, a radio communication system comprising a transmitting station which comprises a plurality of spreading means for spreading transmission data by a plurality of orthogonal codes, a plurality of modulation means for modulating the spread signals that have been spread by the plurality of spreading means, and a plurality of transmission means for transmitting the modulated signals that have been modulated by the plurality of modulation means from a plurality of different transmission antennas in the form of a plurality of radio signals, and a receiving station which comprises reception means for receiving, through a single receiving antenna, the plurality of radio signals that have been transmitted by the plurality of transmission means, a plurality of reverse spreading means for reverse spread and

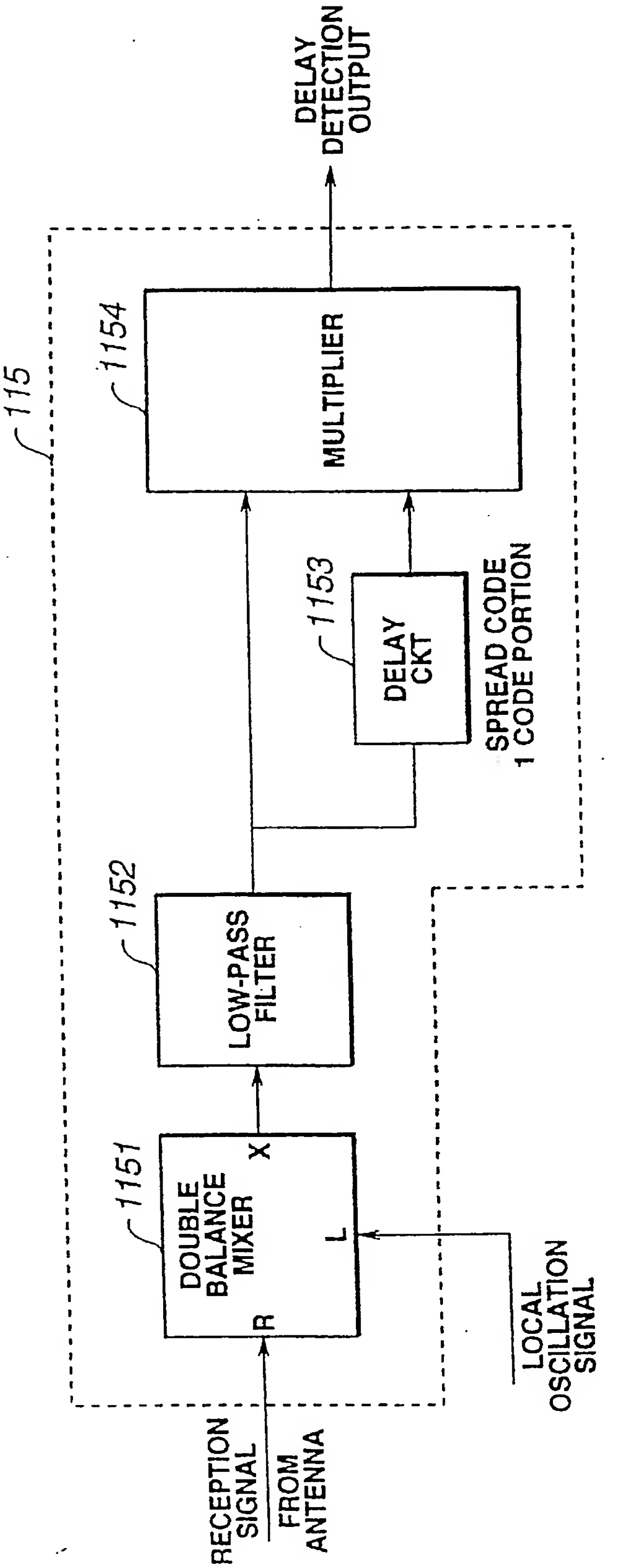

DELAY DETECTION OUTPUT
115
1154
MULTIPLIER
1153
DELAY CKT
SPREAD CODE 1 CODE PORTION
1152
LOW-PASS FILTER
1151
DOUBLE BALANCE MIXER
R
L
X
RECEPTION SIGNAL
FROM ANTENNA
LOCAL OSCILLATION SIGNAL

FIG.16

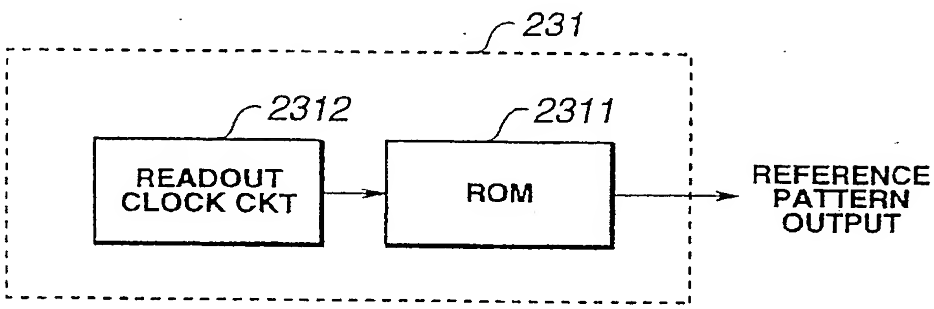

231
2312
2311
READOUT CLOCK CKT
ROM
REFERENCE PATTERN OUTPUT

FIG.14

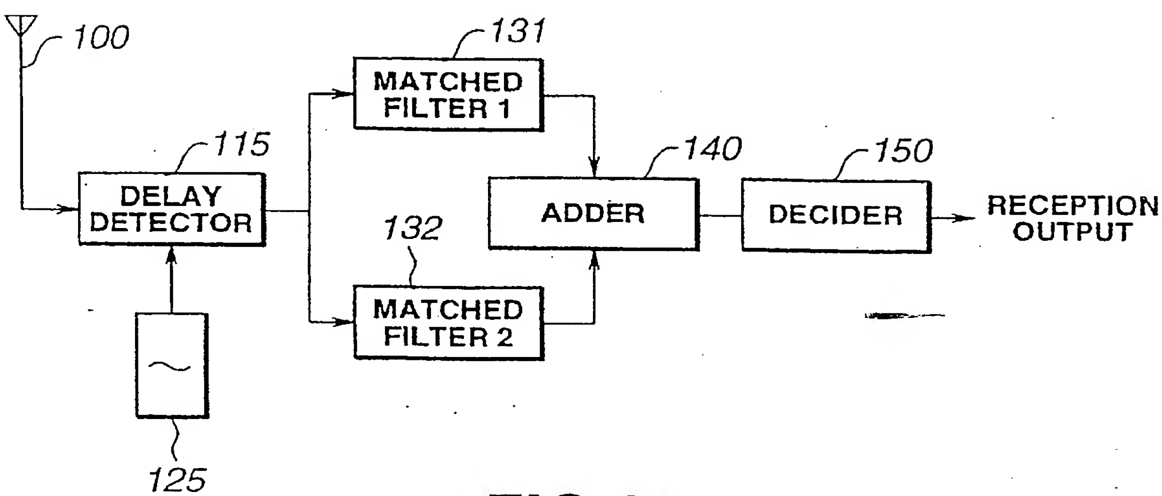
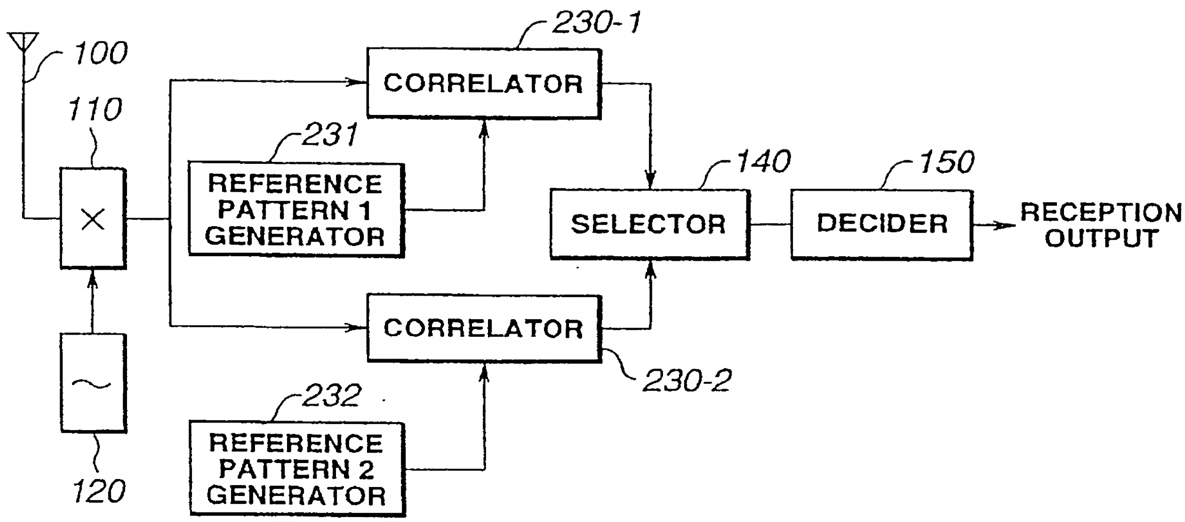
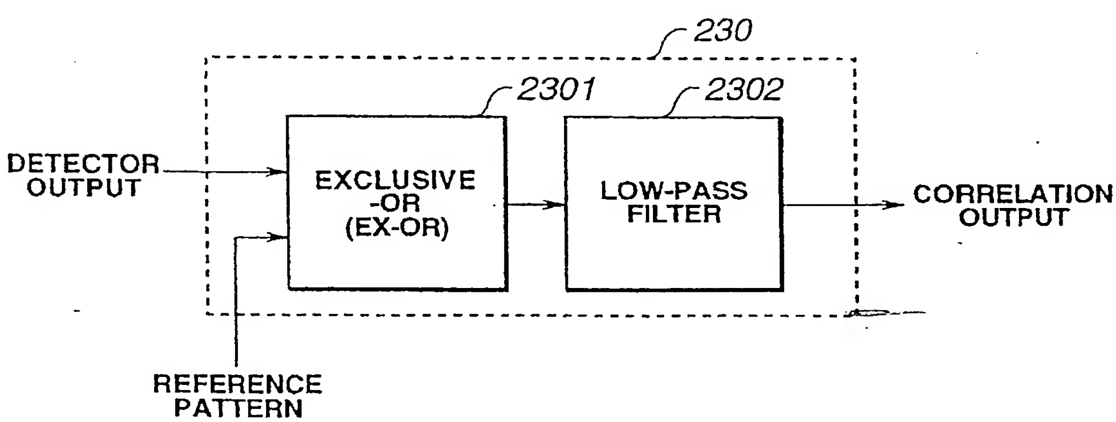

100
131
MATCHED FILTER 1
115
140
150
DELAY DETECTOR
ADDER
DECIDER
RECEPTION OUTPUT
132
MATCHED FILTER 2
125

FIG.15



100
110
120
230-1
CORRELATOR
231
REFERENCE PATTERN 1 GENERATOR
140
SELECTOR
150
DECIDER
RECEPTION OUTPUT
CORRELATOR
230-2
232
REFERENCE PATTERN 2 GENERATOR

FIG.12



230
2301
2302
DETECTOR OUTPUT
EXCLUSIVE -OR (EX-OR)
LOW-PASS FILTER
CORRELATION OUTPUT
REFERENCE PATTERN

FIG.13

97·10·05

说　明　书

同步码分多址通信链路的建立和保持方法

本发明涉及一种无线通信的同步码分多址(SCDMA)通信系统，更确切地说是涉及 SCDMA 通信系统的链路建立与保持方法。

近年来，无线通信，例如无线用户环路、蜂窝移动通信、个人通信服务和无线数据网等已成为通信领域中最活跃的一个方面，无线接入技术的发展方向已集中到码分多址(CDMA)系统，即一个允许多终端在同一个小区内同时使用相同频段的 CDMA 无线通信系统。每一终端单元利用统一分配的编码或者伪噪音(PN)序列发送和接收信号。CDMA 系统有许多优点，包括信号保密、高的信道容量和抗干扰等等。但是目前存在的多数 CDMA 系统，例如美国专利 5416797 及 5309474 等都是非同步方案，其上行信道，即所有的用户终端发向无线基站的信号是非同步传送的。因为来自不同用户终端的伪噪声序列不能同步，不同用户终端的伪噪音序列相互之间不能形成正交，在同一频段的扩频信号相互间会形成极大的干扰(多址干扰)。这种干扰不仅大大减少了信道容量，还增加了对用户终端进行功率控制的要求。

显而易见，在典型的无线通信系统中，由于不同位置处的终端并不知道自己离最近基站间的距离，所以在同一小区内建立和维持多终端间的同步是不容易的事情，而多径衰落和遮挡效应使建立和保持同步变得更加困难。

近几年来，针对该问题提出了不少技术方案，使 CDMA 系统的上行信道实现同步，如美国斯坦福通信公司的正交 CDMA （ OCDMA)系统所提出的实现同步 CDMA 的方法。但这些方法是以复杂的硬件为代价、以高成本换取的。而且，由于无线通信系统中不可避免的多径传播，将破坏同步，故仅仅解决同步对提高 CDMA 系统的容量是十分有限的。

本发明的目的是设计一种同步码分多址通信链路的建立和保持方法，使一个或多个试图接入基站的用户终端与已经与基站建立通信的终端在基站的接收端同步，并维持同一小区内已与基站建立通信的多个终端之间的同步，还可简单、有效地防止在接入码道时出现争抢，是一种更为简单、有效并成本低廉的同步 CDMA 系统建立和保持通信链路的方法。

本发明的方法是这样实现的，同步码分多址通信链路的建立方法包括以下步骤：

1）．将下行接入码序列设计成至少含有保护时隙、训练序列时隙、用于同步调整的时延偏差时隙、用于功率调整的功率控制时隙的帧结构，将上行接入码序列设计成至少含有保护时隙、同步 1 时隙、空时隙的帧结构，将下行业务码序列

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设计成至少含有保护时隙、空时隙、用于同步调整的时延偏差时隙、用于功率调整的功率控制时隙的帧结构，将上行业务码序列设计成至少含有保护时隙、空时隙、空/同步 2 时隙的帧结构；

2）．基站在下行接入码道中以下行接入码序列向所有终端发射建立通信的下行接入信号，加电终端用已知的通用下行码序列搜索基站的训练序列，识别出上行接入码道及下行接入码道；

3）．终端根据接收的训练序列的信号电平及接入码道的有效区域信息估计终端距基站的距离并估算出延时发射的时间及发射功率，根据估算的发射功率和时延以上行接入码序列发射接入请求信号；

4）．基站搜索使用上行接入码序列的训练信号，将检测到的时延量与系统设定的参考值进行比较后获得时延偏差，将接收到的信号功率电平与现存信号电平进行比较后获得功率控制信号，并在下行接入码道中以下行接入码序列发送信道接入的确认信号；

5）．终端根据接收的下行码序列的时延偏差信号和功率控制信号调整发射时间和功率电平，根据指定的码道号，以上行码序列发射链路的初始信号；

所述同步码分多址通信链路的保持方法是：指定码道号的终端在其上行业务码道中的空/同步 2 时隙，以其上行业务码序列周期性地发射同步 2 符号，基站通过计算相关值和搜索峰值，确定此终端同步 2 信号的到达时间，并根据峰值和时间计算出终端的上行同步误差，在下一个下行业务码道中用同样的下行业务码序列发送此时延偏差信号，供终端调整发射时间保持同步。

所述终端在上行业务码道的空/同步 2 时隙中，只有特定的一个或几个终端在此当前帧中能发射同步 2 信号，其它正在通信的终端只能处于不发射的空时隙，使只有此一个或几个指定的终端的同步 2 信号能被基站接收。

所述上行接入码序列与下行接入码序列间的保护时隙及所述上行业务码序列与下行业务码序列间的保护时隙大于模拟电路的开关时间和大于 2 倍的终端与基站间的最大距离或小区的最大半径与大气中光速之比。

所述的上行信道与下行信道是时间上不重叠的上、下行时隙，在频段上可以相同，上行时隙与下行时隙组成一对，在时间上重复循环。

所述基站下行接入码道中的训练序列时隙与下行业务码道中的空时隙 EMPTY 在时间上是重叠的，即在此下行时隙中，基站只在其下行接入码道中发射训练序列，而其它业务码道在此时隙均不发射；所述终端在上行接入码道中的同步 1 时隙与上行业务码道中的空时隙在时间上是重叠的，即在此上行时隙中，只有要求接入的终端才发射同步 1 信号，而正在通信的其它终端在其上行业务码道的此时隙不发射。

所述的下行接入码道中的训练序列是全向发射的，具有比其他信号高的电平。

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所述链路的建立方法还包括对定时偏差和功率控制信息的差错检测及更正。

所述链路的建立方法还包括对接入请求信号及接入确认信号的终端唯一个人号码 PID 信息的检测。

所述链路的建立方法还包括对接入请求信号、接入确认信号以及链路初始信号的差错检测及更正。

所述的步骤 4 ）中基站发射链路确认信号是在基站接收到上行时隙的接入请求信号后的下一个下行时隙进行的。

所述的步骤 3 ）中，各终端是在其个人号码的最后 5 比特与下行接入码序列的帧号相同时，才在上行时隙发射接入请求信号，在接入失败时，终端随机延时一定时间后再重复发射接入请求信号。

所述的步骤 3 ）中，特定的固定终端记录前一次成功通信时的上行延时值，并在下一次接入时使用该值作为初始延时值。

所述的检测接入请求信号的训练序列，还进一步包括：以一个码片周期几分之一的精度，使用上行接入码序列在基站计算接收到的信号的相关峰，找到超过预定门限值的相关峰，将确认的相应时间作为到达时间的数值；如果任一个到达时间的数值处于以参考时间为中心的一个预先确定的范围内，选取最接近参考时间的那个时间数值作为到达时间的目标值，其相应的相关峰作为其功率估值；如果没有一个到达时间的数值落在上述预定范围内，则选取具有最大相关峰的那一个到达时间数值作为到达时间目标值，其相应的相关峰作为目标功率估值；如果没有上述到达时间数值，取上述预定参考时间为目标到达时间数值，取预定参考功率为目标功率估值；所述的计算定时偏差和功率控制范围，其中定时偏差为到达时间目标值与所述参考时间之差，所述功率控制范围为目标功率估值与参考功率的比值；所述的定时偏差和功率控制范围的信息均在下行接入信号、链路确认信号中发射。

本发明的方法还进一步包括防止在接入码道中出现争抢的方法，包括：

1).在下行接入码道的帧结构中设计忙闲 B/I 时隙，在基站所有业务码道均被占用或此接入码道正在处理接入时示忙，当终端接收到下行接入码道的此时隙示忙时，只有特权用户或特殊服务号码（如 119 、 110 、 120 等）呼叫能强行在其上行接入码道中申请强行接入，其它处于等待状态的终端均不能发射上行接入请示信号；

2).上、下行接入码道仅处理终端的接入，而在所分配的业务码道中处理用户鉴权和主叫、被叫电话号码的传送，即接入码道在绝大多数时间内处于空闲状态，使争抢不易出现；

3).将用户终端进行分组处理，基站对用户终端的呼叫和终端的接入请求都只能在分组的特定的上、下行帧中进行，进一步降低争抢出现的概率；

4).出现争抢基站无法分辨所收到的上行接入请求信号和终端无法获得接入的

确认信号时，终端将随机延时一段时间后再次发出接入请求。由于不同终端的随机时延不同，在下一次发出接入请求时就不致形成争抢。

在该 SCDMA 系统中，所有用户终端用相互正交的 PN 序列扩频，而且同步传送，即 PN 序列同时到达基站。这样用户之间的干扰明显减少，可增加系统容量和降低对功率控制的要求。本发明同时在基站使用多单元的天线阵及相关的信号处理技术（见本申请人另一发明专利申请案“具有智能天线的时分双工同步码分多址无线通信系统，中国专利申请号 97104039.7），从而极大地改善了从终端到基站的上行信号接收和从基站到终端的下行信号的发射，解决了多径传播的问题。SCDMA 系统的上行信道同步，就可以充分发挥各码道的正交性作用。

下面结合实施例及附图进一步说明本发明的技术。

图 1 .由一个基站和多个终端组成的无线通信系统结构示意图

图 2 .图 1 中基站的天线阵分系统结构示意图

图 3 .接入码道上下行时隙符号的排列图

图 4 .业务码道上下行时隙符号的排列图

图 5 .一个试图接入基站的终端的通信建立过程的方案示意图

图 6 .一个已经和基站建立通信的终端信道同步保持的方案示意图

图 7.在终端一侧接入过程的操作流程图

图 8.在基站一侧接入过程的操作流程图

参见图 1，图中示出一个用时分双工工作的、具有智能天线的同步 CDMA 无线通信系统，包括一个基站和多个终端，基站配有 CDMA 天线阵系统。其天线阵在基带数字信号处理器的支持下实现了智能天线的功能，能根据发射和接收的要求，有效地把天线波瓣对准不同方位的不同终端。基站在第一个时隙发射扩频信号，此时隙叫下行时隙 DTS 。在第二时隙接收来自终端发射的扩频信号，这个时隙叫上行时隙 UTS 。因此，终端在上行时隙 UTS 发射信号，在下行时隙 DTS 接收信号。一个上行时隙和一个下行时隙构成一组，并在时间上不断重复。UTS 或 DTS 的时间宽度应设置得足够小，以保证在 UTS 或 DTS 的周期内射频或微波传播特性没有明显变化。因为此无线通信系统是使用码分多址方案，每一个 UTS 包含许多码道，并共用同一载波。终端与基站之间建立通信时，均发射被一个 PN 码序列扩频的扩频信号。同样，每一个 DTS 也有多个码道，从基站向与基站通信的或被基站呼叫的终端传送多路下行信号。对于上行或下行信号，所有的码道同时共用同一载波。在这些共 N 条码道中，有一个是接入码道，其余 N - 1 条是业务码道，N 是扩频系数。用通用上行 PN 码扩频的信号是用于接入码道的，而用其他正交 PN 码扩频的信号则用于业务码道。图中所示的每一终端具有一个射频收发信机和一个数字信号处理器，它至少能完成扩频、解扩、调制、解调和信令分析等功能。

参见图 2，示出一个典型的 CDMA 天线阵分系统。具有多个天线 20A 、 20B 、

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20C 和 20D，以及连接到这些天线上的多个无线电收发信机 21A、21B、21C 和 21D。每一个收发信机的发射部分把基带信号调制到指定的射频或微波，同时放大到一定的功率电平，每一部收发信机的接收部分放大射频或微波信号并解调出最初的基带信号。与各收发信机连接的 A／D 变换器 23A、23B、23C 和 23D，把模拟信号变换成相应的数字信号，送数字信号处理器 24。与各收发信机连接的 D／A 变换器 22A、22B、22C 和 22D，把从数字信号处理器 24 来的数字信号变换成相应的模拟信号，送相应收发信机。部件 24 是一个数字信号处理器或多个数字信号处理器，包括扩频器、解扩器、调制器、解调器和空间处理器等基带电路，能完成所要求的信号处理，如扩频、解扩、调制和解调等功能。

参见图 3，该图说明了接入码道 DTS(30)和 UTS(31)帧结构中所有符号的详细安排，一个 DTS 和一个 UTS 构成一对并在时间上分开。由于采用了高性能的差分四相相移键控 DQPSK 射频调制方案，所以每个符号由 2 个比特构成。如果数据率较高，还可以使用其它调制方案。如，8PSK 或 16QAM 调制。图 3 所示的每一个 DTS 帧的周期从保护时隙 32、符号 Sgd 开始，设计此保护的目的是为了避免因为同步或模拟开关时间造成 DTS 与相邻的 UTS 的重叠。这是因为不论对于基站还是终端，收发和发收之间的转换需要一定时间。虽然在同步 CDMA 系统中所有终端的信号要在同一时刻到达基站，但某一终端在开始试图接入基站时，并不可能与已经在与基站通信的终端同步。如果没有保护时间，离基站较远终端发来的信号传播较长时间才到达基站，有可能超出一个 UTS 的极限，使基站无法收到上行信号的开始部分。

紧跟着保护时隙的是下行训练符号 St（33），这些符号实际上是全 1，即 11，并被终端已知的下行伪随机码扩频，以便终端识别和同步。Sf 符号指示出目前的帧号（34），帧号（34）是一个复帧里每个子帧的序号，复帧内子帧的总数 M 是预先确定的。这样帧号（34）总是在 0 与 M-1 之间，每一个新的子帧递增 1，到达 M 就回零。Sc1 符号用于表示控制信令包 35，此包用于从基站向终端发送控制信令，此信息可能由一个控制信令包或多个控制信令包组成，控制信令包用检错和纠错码，即循环冗余码 CRC 进行保护。这个信息包也能用于传送广播信息，如基站的覆盖范围、基站的标识、寻呼、短消息、信道保留、时间、天气和基站的地理位置等。时延偏差 36 使用 Sg1 符号，用于上行接入同步。功率控制 37 使用 Sp1 符号，用于上行接入终端的发射功率控制。此外，还有一个忙闲指示的符号 Sb1（45），用于指示此时接入码道及整个基站的业务码道的忙闲状态。这些符号可能还包括 CRC 校验位，以增强可靠性。

图 3 还示出了 UTS 接入码道的符号安排。UTS 包含的符号总数与 DTS 同样多，这些符号被一种已知的为所有终端通用的上行 PN 码序列扩频。同样，UTS 帧以保护时隙 38、符号 Sgu 周期开始。保护时隙 38 对同步是极其重要的，当一个终端要求接入基站时，它并不知道自己与基站间的距离，也不知道它发射出的

信号在到达基站时的同步偏差，如果 UTS 里没有保护时间，就无法延迟近的终端和提前远的终端的发射时间。准确地说，UTS 和 DTS 之间的保护时间必须大于模拟电路的开关时间，还要大于 2D / C，这里 D 是终端和基站间的最大距离或小区的最大半径，C 是大气中的光速。为方便系统工作，在基站侧 Sgu 和 Sgd 是固定的，也是达到同步所必须的，为此，必须由每一终端根据 DTS 中的 Sg1 数值不断调整 Sgu 和 Sgd。同样，一旦终端的传送同步建立起来，它就能从保护时间里，即从 Sgu 和 Sgd 里计算出终端离基站的距离。紧跟着保护时间的是 S1 符号 SYNC1（39）。同样，这些符号是全 1 符号。然后使用 S2 符号 EMPTY (40)，在此符号期间上行接入码道没有信号发射。SYNC1 符号和 EMPTY 符号在接入操作中将发挥重要作用。控制信令包 41 用符号 Sc1 表示，其控制信息可由一个控制信令包或多个控制信令包组成，包括接入申请信号、终端身份识别 PID 和其它有用信息。因为 UTS 里没有功率控制和同步控制信号。就可以预留一段时间给预留符号 Sr1（42），留待系统设计者使用。

参见图 4，图中示出业务码道 UTS（31）和 DTS（30）帧结构中符号的安排。每一业务码道的 DTS 与接入码道的 DTS 一样也设计有保护时隙 32。紧接着是 EMPTY，符号 St（403），在此期间没有发射。也就是说在 St 符号周期的时隙中，基站仅在接入码道内传送训练序列符号。EMPTY 符号后面使用用于同步调整的时延偏差符号 Ss2（404）、功率控制符号 Sp2（405）和话音速率符号 Svr（406），此符号用于可变速率声码器。这些符号用冗余码 CRC 进行保护，以保证正确接收。控制信令 Sc2（407）的符号数安排得较少，一个控制信令包是用多个帧的 Sc2 符号传送的。Sv 符号 408 用于业务数据信息，它们可以是话音压缩编码或数据。

图 4 还给出了上行业务码道 UTS 符号的安排。在保护时隙符号 Sgu 38 后边是 EMPTY 符号 S1（420），在这段时间内各通信终端均不发射，减少对正在接入终端建立上行同步时的干扰。紧跟着 EMPTY 符号 S1 的是使用 SYNC2 / EMPTY 的符号 S2（411），只要它不空就象 SYNC1 一样，发射全 1 信号。对某一特定的正在通信的终端来说，它将根据帧号周期性地发射 SYNC2 符号。如，一个正在通信的终端，它将在帧号与其码道号相同的那一帧发射 SYNC2 符号，而在其它帧中不发射（EMPTY）。换句话说，在 SYNC2 周期中只有一个终端能够发射，基站接收时干扰电平大大减少，基站容易获得此特定终端信号的到达时间，并发射用于同步调整的时延偏差信号给此终端，以保持终端的同步。在此期间，装有智能天线的基站能更好地获得这些终端的空间向量或矩阵，用于优化上行信道的天线波束赋形，对丢失了上行同步以后的终端特别重要。在此情况下，这个码序列可能与其它码序列不正交，由于来自同一频道其它码道的干扰，基站不能很好的解扩上行信号。同理，基站也不能正确地估计出空间特性向量和矩阵，不能对上下行信道的天线波束准确地赋形。下行信道出现的问题可能使终端不能调

整自己的发射时间，上行信道无法取得同步，最终导致通信中断。由于本发明在每一帧中，只有一个终端能发射 SYNC2 符号 411 ，此时对基站接收仅有小的干扰，尽管失去同步，但基站仍可获得此终端信号的到达时间，获得空间特征向量和矩阵，可有效进行上下行信道的天线波束赋形。同理，因为同波道干扰较小，就能准确地估计出终端的功率，实现闭环功率控制。紧跟着 SYNC2 符号的是话音（声码器）速率符号 Svr （ 412 ），对于 CDMA 系统，检测话音激活和调整声码器速率是很重要的，在话音激活率较低时，可降低发射功率、降低信号速率，有效减少对其它终端的同频道干扰。声码器速率信息对于解压缩是必须的。声码器速率符号后边是控制信令符号 Sc2 （ 413 ），用于传送从终端到基站的空间信令及控制信息。因为在业务码道中，业务信息量比接入过程的大很多， Sc2 比 Sc1 短且不能很长，同样可用多个 UTS 帧的 Sc2 合成前述的控制信令包。最后是业务数据符号 Sv （ 414 ）。由于在 UTS 里没有功率控制和同步符号，可以保留一些符号供以后定义，即 Sr 符号 415 的位置。

图 5 至图 8 全面说明帧结构建立和保持链路的过程。

参见图 5 ，示出链路的建立过程。当终端加电并试图接入经登记的且距离最近的基站时，首先用已知的通用下行码序列搜索基站的训练序列，识别出 UTS 和 DTS 。由于基站训练序列的发射电平明显高于其它信号，且在此期间又无其它信号发射，因此发现此序列不困难。一旦获得训练序列，就可确定 UTS 和 UDS 。当该终端与此 DTS 同步并跟踪上训练序列后，就可对接入码道 的符号进行解码和纠错。终端正确地对这些信息进行解码，检查控制信令里是否有本机的身份识别码 PID ，来确定基站是否在呼叫自己。

终端还能处理接入码道下行信号里的其它有用信息，如时间、天气和短消息等。如果基站呼叫这个终端或这个终端试图接入此基站，且下行接入码道中的忙闲时隙 Sb1 （ 45 ）未示忙，终端就可用另一种通用上行 PN 码进行调制发出接入请求信号。信道忙是基站向终端发出的本基站接入码道忙或业务码道已被占满的信息。在 DTS 的忙闲时隙 Sb1 （ 45 ）示忙时，只有特权用户或特殊呼叫如 110 、 119 、 120 等可强行呼叫接入。

尽管，此时此终端可以接收到基站的同步信号，但由于不知道自己与终端间的距离，因此仍不知道什么时间发射，也无法在基站一侧与其它已建立通信的终端取得同步(误差为码片信号周期的几分之一)。所以此终端还必须取得上行同步。此终端首先检测接收到的训练序列信号的强度，并根据接入码道的有效区信息粗略地估计自己到基站的距离。然后此终端经过一定的时间 延时后开始发射，试图在基站一侧取得与其它正在通信的终端的同步。如一个小区的平均半径是 10 公里，基站将根据这个小区覆盖的要求发射固定功率的电平。如果没有多径和遮挡效应，终端可以根据收到的信号强度粗略估计出自己距基站的距离，假如是 2 公里。若预先设置的参考距离为 5 公里，由于传播延迟，远在 2 公里处的

终端需要将发射时间从原 UTS 的开始时间即参考距离对应的时间延时 $3 \times 10^3 / (3 \times 10^8) = 10\ \mu s$。

然而此开环估计是不准确的，特别在多径干扰和遮挡的情况下更是如此。此终端用上面估算的延时发射用 PN 码调制的 UTS 符号，如图 3 中所示，在 S1 之后的 EMPTY 符号 S2 停止发射，以保留用于 SYNC2 的符号，然后再传送指示 PID 的信息符号和其它建立信道必须的信息。此时基站接收到的第一个 UTS 里的 S1+S2 符号是用于同步的。在此期间绝大部分正在通信的终端并不发射信号。基站在第一个 S1 符号范围内，用公用上行 PN 码解扩并求相关，搜索 SYNC1 符号。一旦基站检测到输出或找到超过门限相关峰值，经一定延迟后，在检测到峰值的地方用相同的 PN 码解扩 S2 符号后边余下的符号。如果余下的信息编码用 CRC 校验或用其它方法检查是正确的，基站就将在下一个 DTS 里向此终端发送信道接入的控制信号。此控制信号里包括了带有可检测的 PID 和分配的码道号等信息的控制信令包，及如图 3 所示 DTS 内的同步调整和功率控制信号。基站将检测到的延时量与系统设定的参考值进行比较，如与终端在小区半径的 1／2 处发射信号的到达时间进行比较，从而得出同步调整信息。基站将接收到的该信号的功率电平与其它现存信号的电平进行比较得到功率控制信息。对于智能天线系统来说，信号功率是所有天线功率的合成，一旦接入的终端单元在 DTS 里收到这些信号，它就知道基站已获得它的接入申请信号，就停止在接入码道传送接入申请信号。它立刻根据接收到的码道号跳入业务码道，根据收到的同步和功率控制信号，分别调整发射时间和功率电平。直至发射时间和功率电平超过了预先设定的门限值。

上述方法被使用于调整发射时间和功率电平的全过程中，如果基站用指定的延时值无法检测到某一终端的 UTS，它就立即忽略这个终端。对能正确解出 UTS 的终端的接入请求信号发送下行信息。如果基站无法正确解出任何控制信令包，它就仅保留与最大相关和解扩相符合的延时量，并在下一个 DTS 里发送它，每一个终端随时记录同步调整和功率控制信息，调整自己的发射时间和发射功率，在下一个 UTS 里再次发出接入请求信号。

一个终端在发送接入请求信号后必须考虑以下情况之一：

1．如果控制信令包能被正确接收，包含了信道接入的控制信号且与此终端相匹配，它就知道基站已正确接收到了它的接入请求信号，根据正确接收到的同步调整和功率控制信号调整发射时间和功率电平，并用下行控制信令包里的码道号，在这个业务码道发送初始化信号。

2．如果控制信令包能被此终端正确接收，包含了信道接入的控制信号，但 PID 与这个终端不匹配，此终端将放弃这个控制信令包，并在另一个 UTS 里用与前次相同的发射时间和功率电平发送接入请求信号。

3．如果正确接收到的控制包不是针对本终端的信道接入信号，此终端仍将根

据正确接收到的发射时间和功率电平分别调整发射时间和功率电平，并在下一帧UTS 重新发射接入请求信号。

4.如果终端在接收到的下行信号帧中检测到任何错误，在随机等待数帧后，用原来的发射时间和功率电平再次发射接入请求信号。

5.如果终端接收到的下行接入信号帧中的忙闲位示忙，则只有特权用户或呼叫特殊服务号码的终端能申请接入，其它未接入的终端均不能发射任何信号，如果终端在一定时间周期如 M 帧内执行以上操作后不能接入基站，就直接退出该过程而进入待机状态，

基站在发送了供终端接入的信道接入控制信号后，立即开放由码道号指示出的业务码道，并等待正确接收信道初始化信号和开始握手过程，包括用户终端身份识别和接收电话号码。在此终端进入业务码道一段时间后，若信道仍没有建立起来，基站就向此终端发送一个中断信号并收回这个业务码道。以上说明了SCDMA 系统建立信道的完整过程。

参见图 6，图示描述了基站与正在通信的终端间保持通信信道同步的一个方案。在同步 CDMA 通信系统中，保持通信最重要的工作是维持上行码道的同步.

图中，每当帧号等于码道号时，使用此码道号的终端就周期性地发射 S2 即SYNC2 符号。因为在 SYNC2 符号发射期间，一般只有唯一的一个信号出现，该时刻干扰很小，基站通过计算相关值和搜索峰值，很容易确定此终端信号的到达时间。根据峰值和时间，就可计算出终端的上行同步误差，并在下一个下行码道发送相应的同步调整信号，使终端能正确地调整发射时间，保证同步可靠。在一个窄带的 CDMA 系统中，由于本振频率偏差或陆地移动速度所造成的同步偏差相对终端的检测周期是很小的，因此不需要给同步调整信号分配许多比特。

而宽带 CDMA 系统，随着信道容量的增加及码道的增多，每一终端维持上行同步保持操作的频度可能降低，为了跟踪快速移动和有时钟突变的终端，就需要以更高的频度发射 SYNC2 信号。在此情况下，可利用~~业务~~码道的下行控制信令包去控制正在通信的终端，以增加 SYNC2 信号的发射频度。如果基站要求一个指定的终端在 M 帧的时间内加倍发射 SYNC2 信号，当帧号满足 nf=nc 或者 nc=mod(nc+M / 2,M)，终端发射 SYNC2 信号。其中 nf 是目前的帧号，nc 是码道号，M 是总码道数，为偶数，mod(x)是 x 的求模函数。在此情况下，基站可能同时收到两个不同终端发来的 SYNC2 信号，但由于这两个 SYNC2 信号分别被不同的 PN 码序列扩频，因此基站仍能分别确定两组 SYNC2 信号到达的时间，并对两个终端分别发送同步调整信号。通过在基站和终端之间交换控制信令包，使保持信道同步。

无论对基站还是对终端，如果在一定时间内，控制信令包内的 CRC 校验总发现错误，或基站丢失了上行信道，就需要重建信道。可由基站发起，要求终端发送上行接入信令，实现再接入。即要求终端在接入码道发送 UTS，含 SYNC1 信

号和控制信令包，如果基站正确接收了此终端的接人请求控制信令包，就采用信道建立的方法处理它并将原码道分配给它。也可由终端发起，要求链路重建，在基站正确接收到此请求后向此终端发出链路重建指令，并在接人码道上按前述过程重建链路。在一个更长的时间内，若链路重建失败，基站将收回业务码道，停止上述链路的重建过程。

对于智能天线阵系统，还可在 SYNC2 时隙准确估算出此终端的空间特征向量和矩阵，用于随后的上行信道天线波束赋形。因为使用 TDD 方案，利用这些空间特征向量和矩阵也同时完成了下行信道天线波束的赋形。

参见图 7，图示介绍了在终端一侧建立信道的过程。终端首先执行过程 800，即在 DTS 里搜索训练序列。根据从过程 800 中计算出来的信号到达时间，获得下行同步，此终端在过程 801 解扩余下的下行信号并解出符号。然后执行过程 802，包括对解码后符号的 CRC 校验和分析。如果通过 CRC 校验，发现呼叫信息中的 PID 和终端 PID 匹配，终端则进人过程 803，否则进人过程 811，检查本终端的用户是否有信道申请。如果没有，终端返回过程 800；如果有申请，则在过程 845 中检查 DTS 中的忙闲指示，若末见示忙或是特权用户或是呼叫特殊服务，都返回过程 803，否则均返回过程 800。

在过程 803，根据下行信号功率的估值和从下行接人信号中得到的基站功率电平信息，终端估算出距基站的距离、发射时间偏移及发射功率，试图使自己的信号与其它正在通信的终端的信号能同时到达基站，并使自己在基站一侧有与其它正在通信的终端相同的功率电平。然后终端执行过程 804，设置上行同步试探的最大次数 m=M 并执行过程 805，即用估计的传送时间偏移和功率在一个 UTS 里发送接人请求信号。发送接人请求信号后，终端立即接收下行信号，并在过程 806 对接收的数据进行 CRC 校验，如果校验通过，且此信号是信道接人的控制信号，即进人过程 807，检查收到的 PID 与自己的是否一致。当过程 806 中的 CRC 校验出错则执行过程 813，对收到的功率控制和反馈回来的同步调整信号进行 CRC 校验。如果正确，就进人过程 814，并依据正确数据调整发射时间和功率电平；否则终端保留原发射时间和功率电平跳过过程 814。如果在过程 807 中发现 PID 不一致，也将跳过过程 813 和 814，进人过程 815。如果在过程 807 中发现接收 的 PID 与自己相匹配，终端就知道基站的信道接人控制信号已经发给自己。然后执行过程 808，即检查收到的功率控制和同步调整符号是否正确(如用 CRC 校验)。如果正确则进人过程 809 并根据正确数据调整发射时间和功率电平。如果不正确就保持原数据跳过 809 进人 810，按信道接人控制信号里指定码道号的 PN 码扩频，发出信道初始化信号。

在接人失败后，终端在过程 815 中，根据预定的概率分配一个随机的延迟时间变量 n，进人延迟过程 816，搜索下行接人信号和对控制信号解码。在过程 816，即使终端收到了基站的呼叫信号也不立即响应，而是等待此随机变量 n 是

否变为 0。如果是 0，终端进入过程 818，在下一个 UTS 里发送另一个申请接人信号。否则执行过程 830，即 n=n-1 并返回过程 816。过程 817 和 830 意味着终端要随机地等待数帧以后再发射另一个接入请求信号，以减少与其它终端的信道争用。过程 817 以后，终端执行过程 818，将接入次数减 1，m=m-1，再进入过程 819 进行比较。如果结果为 0，说明终端已经发射了 M 次信道请求信号，还无法接人系统，则终端在过程 800 退出接入过程返回待机状态，否则继续试图与基站建立通信。

参见图 8，示出基站一侧的信道建立过程。在过程 900，基站首先对功率控制和同步调整符号置 0。在过程 902，基站在与覆盖范围相应的时间内搜索 SYNC1 符号，即在 SYNC1 时隙用已知的上行接入码序准确地进行相关计算。在下一过程 904，基站观察相关值是否大于预定的门限，此门限值包括从接收信号计算出来的噪声电平、相关的时间精度等。相关的时间精度一般是扩频码片周期的几分之一，如 1／8 码片周期。得到相关值后，基站首先检查相关值是否集中在预定的时间内，即半个码片的时间。如果正确，基站跳过过程 906 进入过程 908。否则基站在 906 用最大相关值与门限比较。如果大于门限，基站才能进入过程 908，如果小于门限则进入过程 920。

在过程 908，根据相关值和相关时间过程 904 或 906，基站计算该上行信号的同步调整及功率控制符号。在紧跟的过程 910 中，基站检查是否有可供使用的空闲码道。如果没有，则将 DTS 的忙闲位置忙并进入过程 918，随同步调整和功率控制符号发出信道 忙信号。如果有空闲信道则进入过程 912，即用过程 908 的时间信息对接收到的控制信令包解码。在过程 914，基站对解码符号进一步作 CRC 校验。如果校验通过，解出接入请求信号，进入过程 916，在下一个 DTS 里随功率控制和同步调整符号一同送出信道接入的控制信号。否则基站回到过程 920，与功率控制和同步调整符号一起发出上层的控制信令包。过程 920、918 或 916 后，基站回到起点 900。在此，如果基站收到的不是信道请求信号，如是短消息信号，基站则仅需送一回答信号，而不送信道接入的控制信号。

由图 5 至图 8 的说明可知，本发明接入码道的效率是很高的。所有终端在申请接入时，只要处于正常通信的范围，即基站的覆盖区内，一般只需几个 TDD 周期就可获得接入确认的 DTS，即通信接入的控制信号，并立即转入业务码道去完成接入的初始化过程。此外，在接入码道中设计了忙闲时隙，使正在接入的终端不致受到其它要求接入终端的干扰，更保证了特权用户和特殊服务呼叫的快速接入。

以上方法可在一个基站中仅用一条接入码道来完成，且此码道一般处于空闲状态，还可用于发射各种广播信息和短消息，大大提高系统容量和效率。

本发明的在时分双工智能天线同步 CDMA 系统中的信道建立和保持方法，可进一步扩展用于 FDD 系统、单天线或扇形波瓣天线系统、 FDMA 和 TDMA 无线

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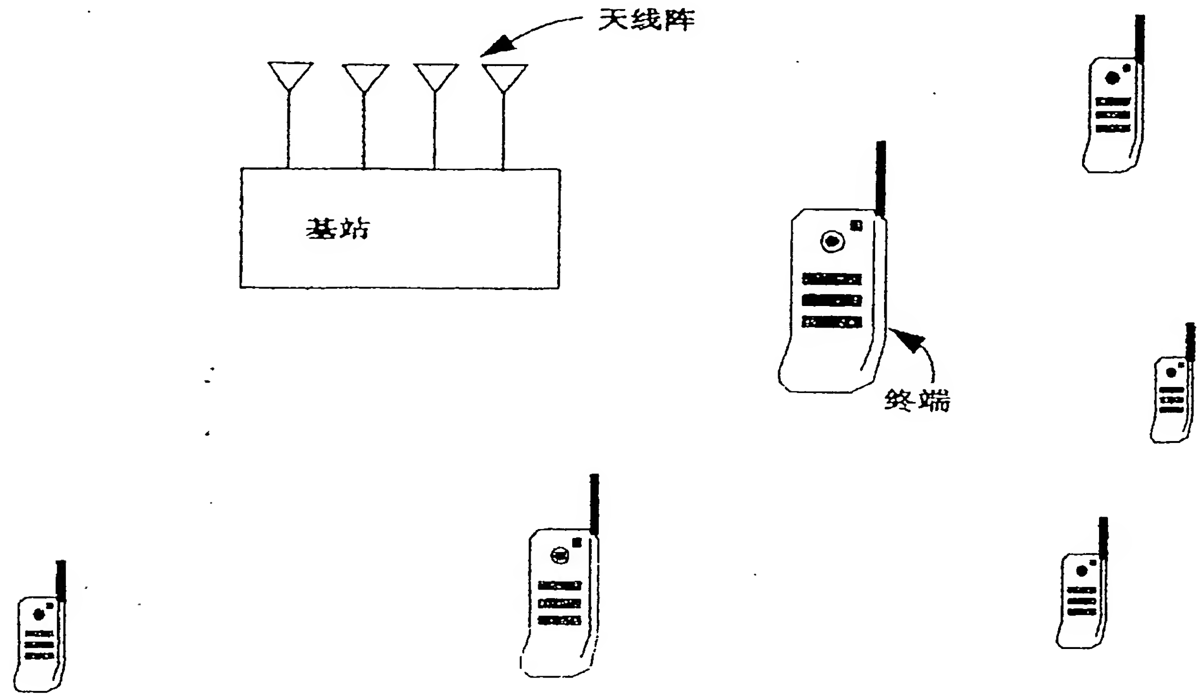
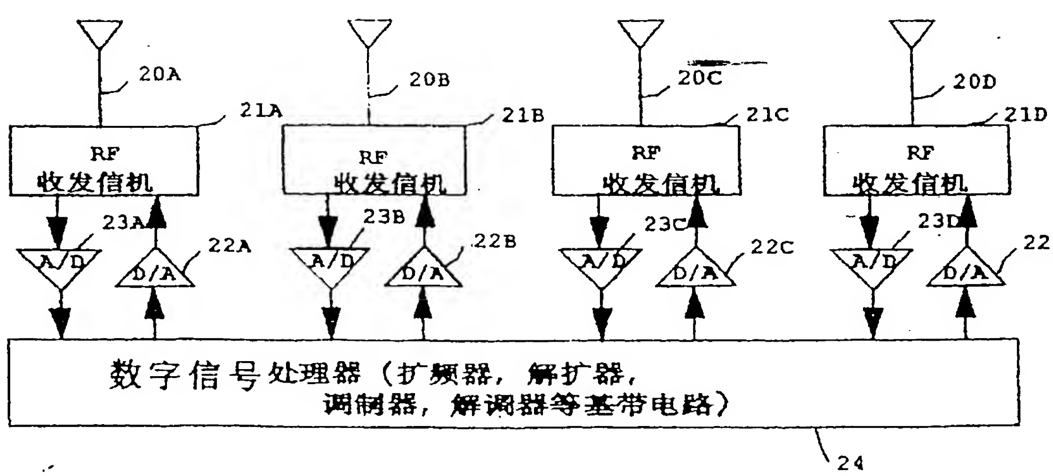
通信系统中，甚至用于有线通信系统、象电缆调制器系统中等.

说 明 书 附 图



天线阵
基站
终端

图 1



20A
20B
20C
20D
21A
21B
21C
21D
RF
收发信机
RF
收发信机
RF
收发信机
RF
收发信机
23A
23B
23C
23D
22A
22B
22C
22D
A/D
D/A
A/D
D/A
A/D
D/A
A/D
D/A
数字信号处理器（扩频器，解扩器，
调制器，解调器等基带电路）
24

图 2

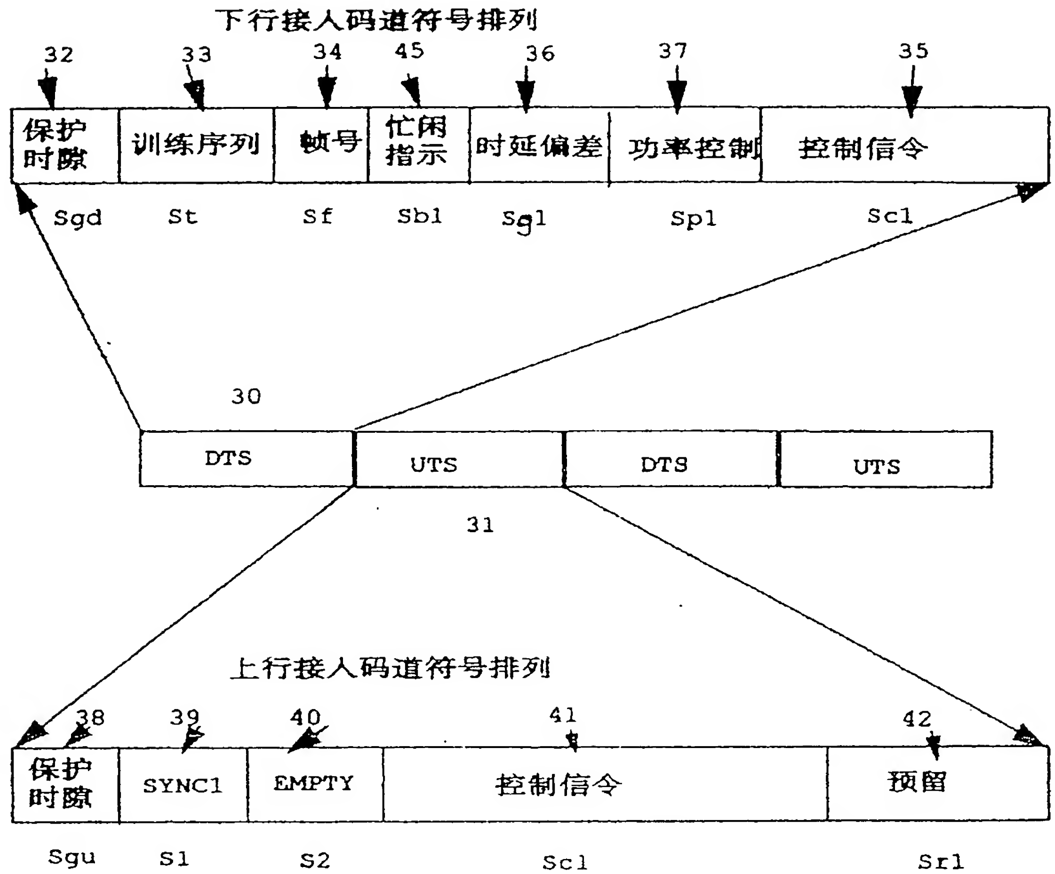

下行接入码道符号排列
32
33
34
45
36
37
35
保护时隙
训练序列
帧号
忙闲指示
时延偏差
功率控制
控制信令
Sgd
St
Sf
Sb1
Sg1
Sp1
Sc1
30
DTS
UTS
DTS
UTS
31
上行接入码道符号排列
38
39
40
41
42
保护时隙
SYNC1
EMPTY
控制信令
预留
Sgu
S1
S2
Sc1
Sr1

图 3

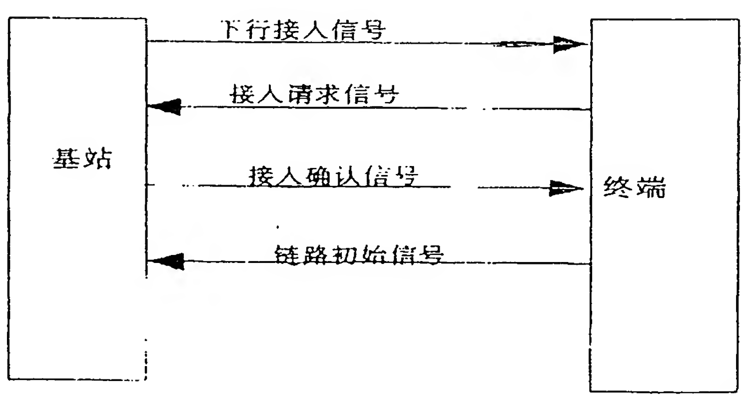

基站
终端
下行接入信号
接入请求信号
接入确认信号
链路初始信号

图 5

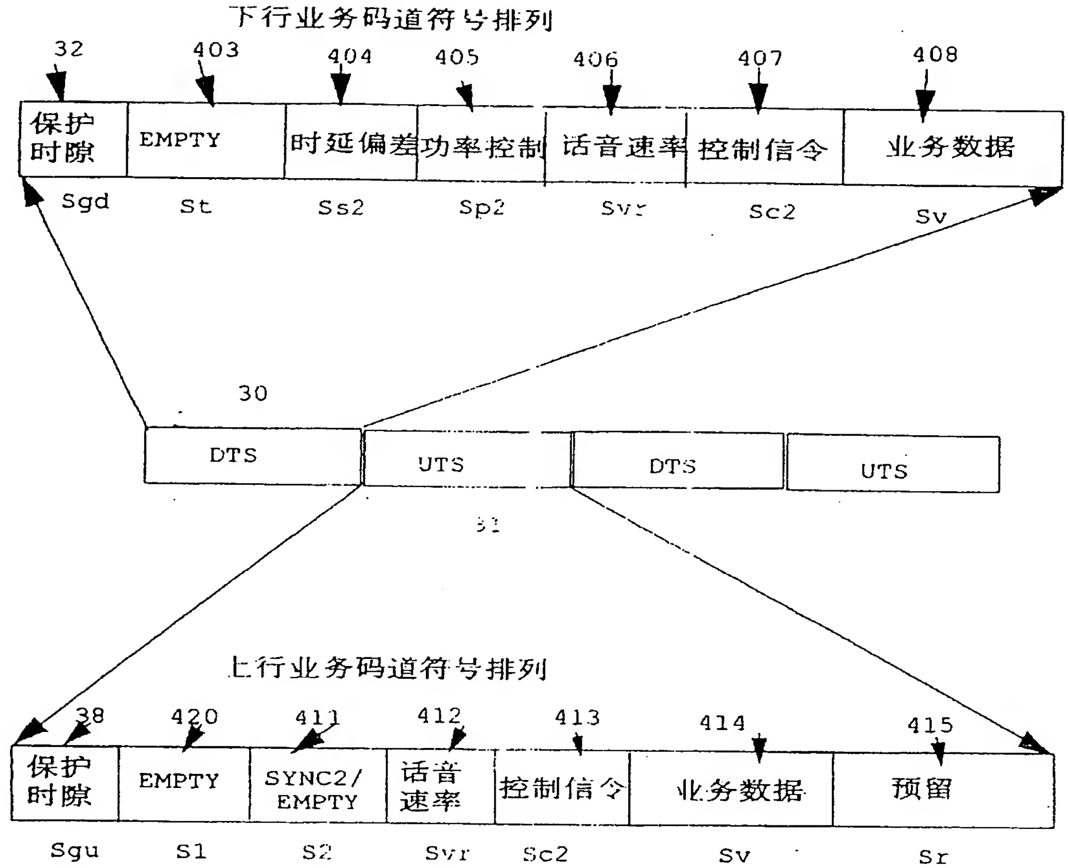

下行业务码道符号排列
32
403
404
405
406
407
408
保护时隙
EMPTY
时延偏差
功率控制
话音速率
控制信令
业务数据
Sgd
St
Ss2
Sp2
Svr
Sc2
Sv
30
DTS
UTS
DTS
UTS
31
上行业务码道符号排列
38
420
411
412
413
414
415
保护时隙
EMPTY
SYNC2/EMPTY
话音速率
控制信令
业务数据
预留
Sgu
S1
S2
Svr
Sc2
Sv
Sr

图 4

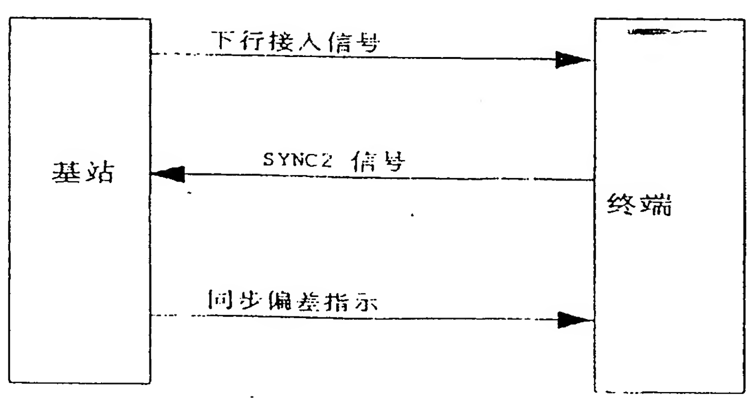
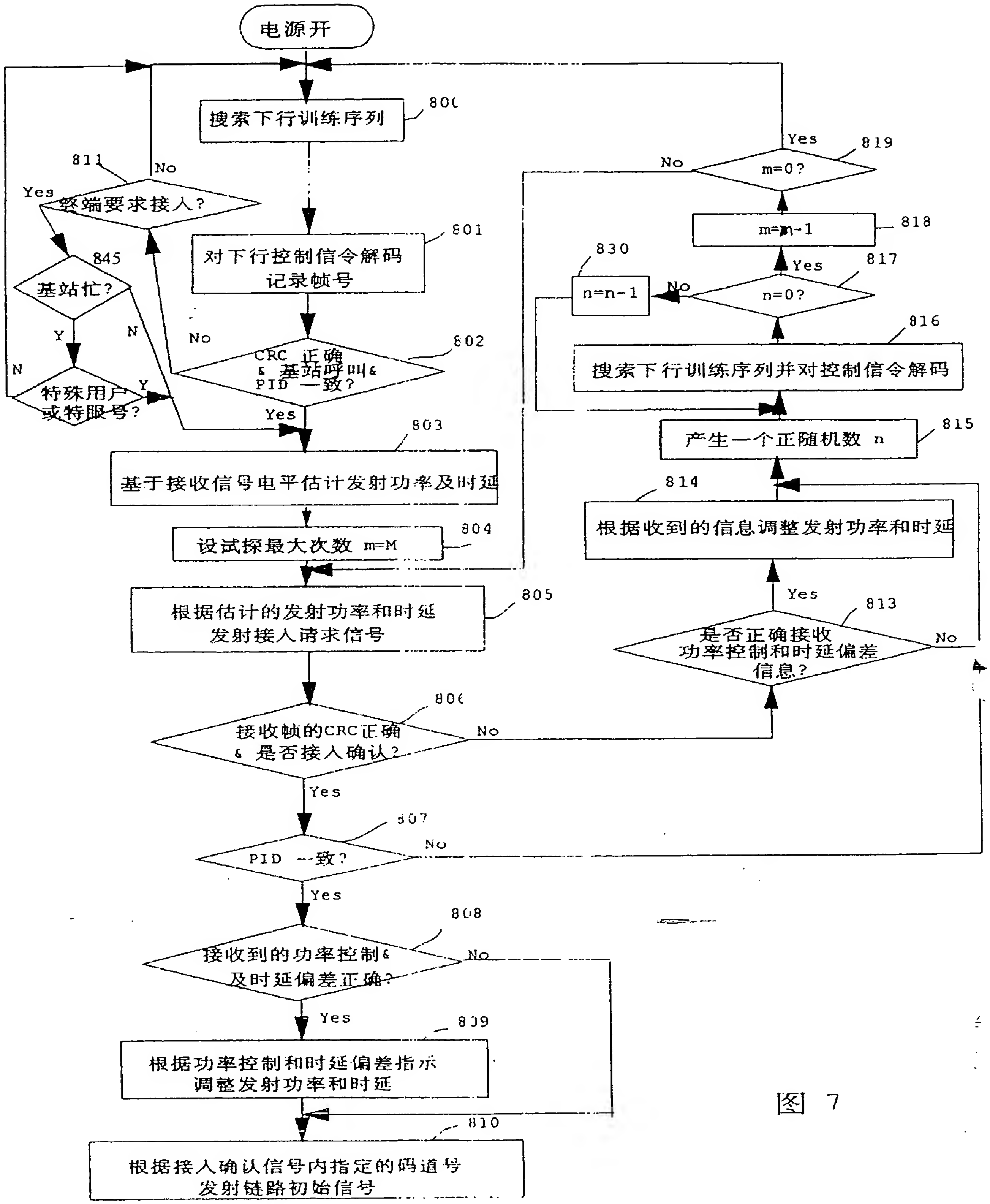

下行接入信号
基站
SYNC2 信号
终端
同步偏差指示

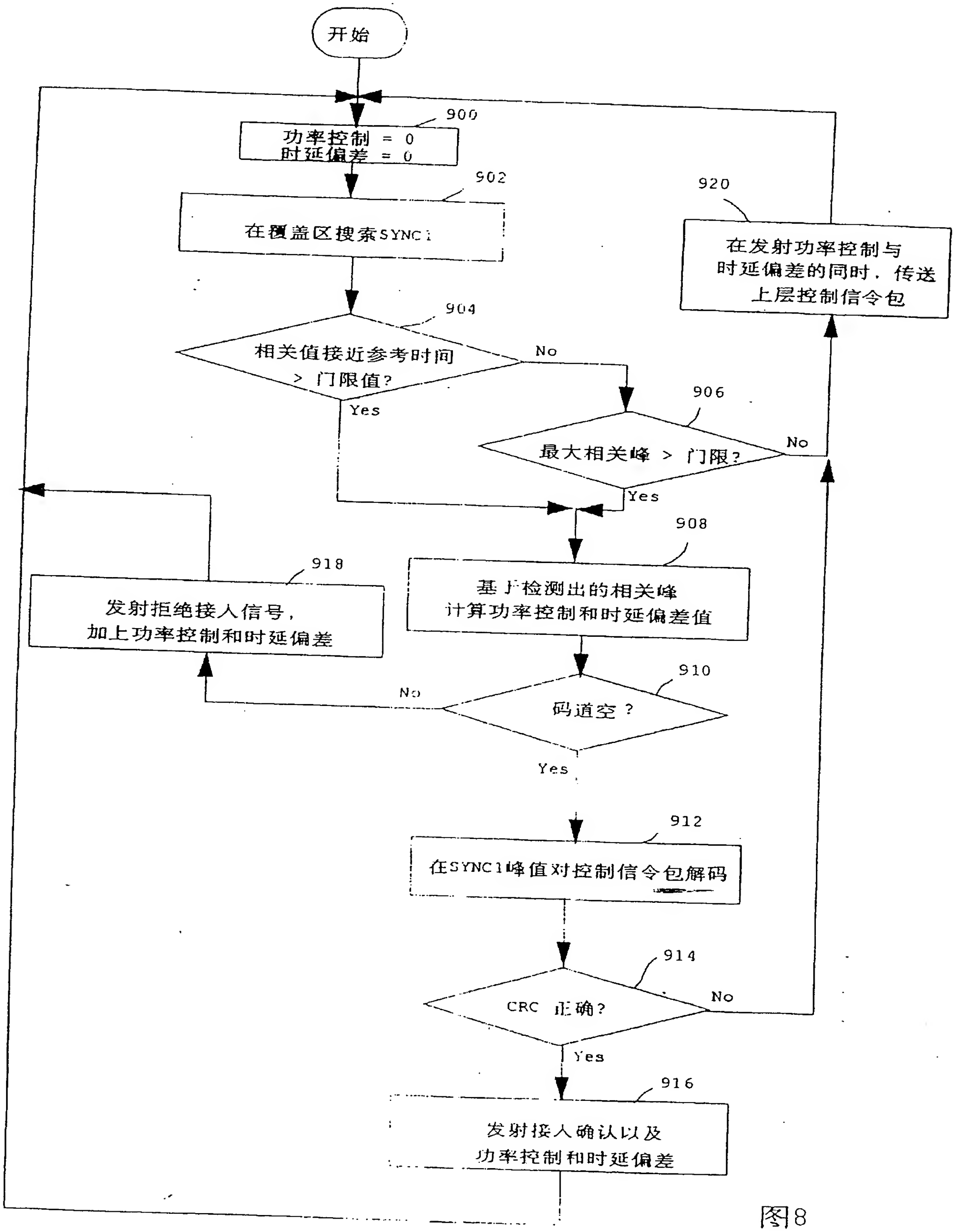
图 6



电源开
搜索下行训练序列
800
对下行控制信令解码
记录帧号
801
CRC 正确
& 基站呼叫&
PID 一致？
802
No
Yes
终端要求接入？
811
Yes
No
基站忙？
845
Y
N
特殊用户
或特服号？
Y
N
基于接收信号电平估计发射功率及时延
803
设试探最大次数 m=M
804
根据估计的发射功率和时延
发射接入请求信号
805
接收帧的CRC正确
& 是否接入确认？
806
Yes
No
PID 一致？
807
Yes
No
接收到的功率控制&
及时延偏差正确？
808
Yes
No
根据功率控制和时延偏差指示
调整发射功率和时延
809
根据接入确认信号内指定的码道号
发射链路初始信号
810
是否正确接收
功率控制和时延偏差
信息？
813
Yes
No
根据收到的信息调整发射功率和时延
814
产生一个正随机数 n
815
搜索下行训练序列并对控制信令解码
816
n=0？
817
Yes
No
n=n-1
830
m=m-1
818
m=0？
819
Yes
No

图 7

105



开始
900
功率控制 = 0
时延偏差 = 0
902
在覆盖区搜索SYNC1
904
相关值接近参考时间 > 门限值?
No
Yes
906
最大相关峰 > 门限?
No
Yes
908
基于检测出的相关峰
计算功率控制和时延偏差值
910
码道空 ?
No
Yes
918
发射拒绝接人信号,
加上功率控制和时延偏差
912
在SYNC1峰值对控制信令包解码
914
CRC 正确?
No
Yes
916
发射接入确认以及
功率控制和时延偏差
920
在发射功率控制与
时延偏差的同时,传送
上层控制信令包

图8